

**PATENT COOPERATION TREATY
PCT**

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

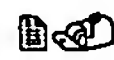
Applicant's or representative's file reference PG 06339WO	<i>FOR FURTHER ACTION</i> See Form PCT/IPEA/416																	
International Application No. PCT/EP2005/000347	International filing date (<i>day/month/year</i>) 14 January 2005	Priority date (<i>day/month/year</i>) 15 January 2004																
International Patent Classification (IPC) or national classification and IPC INV. F02B33/34 F02B41/10 F02B37/10 F02B37/00 F02B39/08 F16D33/16																		
Applicant VOITH TURBO GMBH & CO. KG et al.																		
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the Applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p style="margin-left: 20px;">a. <input checked="" type="checkbox"/> (<i>sent to the Applicant and to the International Bureau</i>) a total of 3 sheets, as follows:</p> <p style="margin-left: 40px;"><input checked="" type="checkbox"/> sheets of the description, claims, and/or drawings, which have been amended and are the basis for this report, and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p style="margin-left: 40px;"><input type="checkbox"/> sheets that supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. 1 and the Supplemental Box.</p> <p style="margin-left: 20px;">b. <input type="checkbox"/> (<i>sent to the International Bureau only</i>) a total of <i>i></i> (indicate type and number of electronic medium(media), containing a sequence listing and/or a table related thereto, in computer readable form only, as indicated in the Supplemental Box relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>																		
<p>4. This report contains indications relating to the following items:</p> <table style="width: 100%; border: none;"><tr><td style="width: 10%;"><input checked="" type="checkbox"/> Box No. I</td><td>Basis of the Office Action</td></tr><tr><td><input type="checkbox"/> Box No. II</td><td>Priority</td></tr><tr><td><input type="checkbox"/> Box No. III</td><td>Non-establishment of opinion with regard to novelty, inventive step, and industrial applicability</td></tr><tr><td><input type="checkbox"/> Box No. IV</td><td>Lack of unity of invention</td></tr><tr><td><input checked="" type="checkbox"/> Box No. V</td><td>Statement with grounds according to Article 35(2) with regard to novelty, inventive step, and industrial applicability; documents and explanations supporting such statement</td></tr><tr><td><input type="checkbox"/> Box No. VI</td><td>Certain documents cited</td></tr><tr><td><input type="checkbox"/> Box No. VII</td><td>Certain defects in the international application</td></tr><tr><td><input type="checkbox"/> Box No. VIII</td><td>Certain observations on the international application</td></tr></table>			<input checked="" type="checkbox"/> Box No. I	Basis of the Office Action	<input type="checkbox"/> Box No. II	Priority	<input type="checkbox"/> Box No. III	Non-establishment of opinion with regard to novelty, inventive step, and industrial applicability	<input type="checkbox"/> Box No. IV	Lack of unity of invention	<input checked="" type="checkbox"/> Box No. V	Statement with grounds according to Article 35(2) with regard to novelty, inventive step, and industrial applicability; documents and explanations supporting such statement	<input type="checkbox"/> Box No. VI	Certain documents cited	<input type="checkbox"/> Box No. VII	Certain defects in the international application	<input type="checkbox"/> Box No. VIII	Certain observations on the international application
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Date of submission of the request 7 November 2005	Date of completion of this report 7 April 2006																	
Name and mailing address of the International Patent Examination Authority [seal] European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Netherlands Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized officer Schmitter, T [seal] European Patent Office Tel. +31 70 340-1015																	


**INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY**


International Reference
PCT/EP2005/000347

Box No. I Basis of the report

2. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

 This report is based on the translation from the original language into the following language, which is the language of the translation furnished for the purposes of:

-  international search (under Rules 12.3 and 23.1 (b))
- ☐ publication of the international application (under Rule 12.4)
- ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

 With regard to the **elements*** of the international application, this report is based on (*replacement sheets that have been furnished to the Receiving Office in response to an invitation under Article 14 and are referred to in this report as "originally filed" and are not annexed to this report*):

Description, Pages

2-7 as originally filed

1, 1a received on 9 November 2005 with letter of 7 November 2005

Claims, No.

2-10 as originally filed

1 received on 9 November 2005 with letter of 7 November 2005

Drawings, Sheets

1/1 received on 9 November 2005 with letter of 7 November 2005

- ☐ a sequence listing and/or any related table(s) – see Supplemental Box relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ description, pages:
- ☐ claims, Nos.:
- ☐ drawings, sheets/figs:
- ☐ sequence listing (*specify*):
- ☐ any table(s) related to the sequence listing (*specify*):

4. ☐ This report has been established without consideration of (some of) the amendments annexed to this report and listed below, since they have been considered to go beyond the disclosure filed for the reasons given in the opinion of the Authority, as indicated in the Supplemental Box (Rule 70.2 (c)).

- ☐ description, pages:
- ☐ claims, Nos.:
- ☐ drawings, sheets/figs:
- ☐ sequence listing (*specify*):
- ☐ any table(s) related to the sequence listing (*specify*):

* If item 4 applies, some or all of those sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY**

International Reference
PCT/EP2005/000347

Box No. V Statement with grounds according to Article 35 (2) with regard to novelty, inventive step, and industrial applicability; documents and explanations supporting such statement

1. Statement
- | | | |
|-------------------------------|------|--------------|
| Novelty (N) | Yes: | Claims 1-10 |
| | No: | Claims |
| Inventive step (IS) | Yes: | Claims 1-10 |
| | No: | Claims |
| Industrial applicability (IA) | Yes: | Claims: 1-10 |
| | No: | Claims: |

2. Documents and explanations (Rule 70.7):

See Annex

Box No. V

Reasoned statement with regard to novelty, inventive step, and industrial applicability; citations and explanations supporting such statement

Reference is made to the following document:

D1: D1: EP-A-0 301 547 (ISUZU MOTORS LIMITED) Feb. 1, 1989 (02/01/1989)

Document D1 is viewed as the nearest prior art with respect to the subject of claim 1. It discloses (the references in parentheses refer to this document):

a turbo-compound system, having a crankshaft (15) driven by an internal combustion engine (1);

having an exhaust gas turbine (12) arranged in the exhaust-gas flow of the internal combustion engine (1);

having a hydrodynamic coupling (21), comprising a primary impeller (21b) and a secondary impeller (21c), which together form a working chamber (21b, 21c), which can be filled or is filled with a working medium, the hydrodynamic coupling (21) being arranged in a driven connection between the crankshaft (15) and the exhaust-gas turbine (12) in such a way that, when the working chamber (21b, 21c) of the hydrodynamic coupling (21) is filled, for an exhaust gas turbine (12) driven by an exhaust-gas flow, driving power is transmitted from the exhaust gas turbine (12) to the crankshaft (15).

Therefore, the subject of claim 1 differs from the known turbo-compound system in that a switching means for reversing the direction of rotation of the primary impeller or of the secondary impeller of the hydrodynamic coupling is provided, so that the primary impeller and the secondary impeller of the hydrodynamic coupling rotate in opposite directions to each other and create a counter-rotating retarder.

The subject of claim 1 is accordingly novel (PCT Article 33(2)).

Although the turbo-compound system from D1 achieves a certain braking effect in braking operation, it has been shown in practice that the switching to the exhaust gas turbine as compressor has not applied a satisfactory uniform braking torque on the crankshaft. In the systems with a fixed blade wheel of the hydrodynamic coupling, by contrast, the braking torque produced during retarder operation of the hydrodynamic coupling, by means of which the crankshaft of the internal combustion engine is braked, depends strongly on the rpm and is accordingly likewise non-uniform.

The invention is based on the problem of presenting a turbo-compound system that makes available an especially uniform and high braking torque in an overrun mode of the internal combustion engine, particularly in a precisely predictable and controllable manner.

The solution to this problem proposed in claim 1 of the present Application is based on an inventive step (PCT Article 33(3) PCT) for the following reasons:

The inventive turbo-compound system has a switching means for reversing the direction of rotation of the primary impeller or of the secondary impeller of the hydrodynamic coupling, so that, in so-called "retarder operation," that is, in an operating state of the turbo-compound system in which a braking power is to be applied to the crankshaft of the internal combustion engine, particularly when the latter is in an overrun mode, the primary impeller and the secondary impeller of the hydrodynamic coupling rotate in opposite directions to each other and accordingly create a so-called counter-rotating retarder.

Claims 2 to 10 are dependent on claim 1 and accordingly also comply with the requirements of the PCT in regard to novelty and inventive step.

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Turbo-Compound System

The invention relates to a turbo-compound system, that is, a system for increasing the efficiency of transmission of exhaust-gas energy of an internal combustion engine, which is arranged in a drive train, via an exhaust gas turbine and a hydrodynamic coupling to the crankshaft of the internal combustion engine. The system that the invention relates to could also be referred to as a turbo-compound/retarder system, because, at the same time, it has a retarder function, that is, it can afford a braking effect on the crankshaft of the internal combustion engine, when this is required.

Turbo-compound systems as well as turbo-compound retarder systems are known to the person skilled in the art. The latter systems, in particular, have, as a rule, a hydrodynamic coupling, which serves for torque transmission between the exhaust gas turbine and the crankshaft of the internal combustion engine. In order to provide the described braking function, as a rule, either a blade wheel of the hydrodynamic coupling is mechanically fixed in place, so that a retarder is functionally created from the hydrodynamic coupling, or the exhaust gas turbine is operated as a compressor; see, for example, the U.S. Patent Specification 5,884,482. In regard to the last-named system, it is also known to reverse the direction of rotation of the exhaust gas turbine in braking operation in order to produce a higher braking torque; see, for example, the U.S. Patent with the number US 4,748,812.

<page 1a>

Although these systems achieve a certain braking effect in braking operation, it has been shown in practice that the switching to the exhaust gas turbine as a compressor has not applied a satisfactory uniform braking torque on the crankshaft. In the systems with a fixed blade wheel of the hydrodynamic coupling, by contrast, the braking torque produced during retarder operation of the hydrodynamic coupling, by means of which the crankshaft of the internal combustion engine is braked, depends strongly on the rpm and is accordingly likewise non-uniform.

AMENDED SHEET

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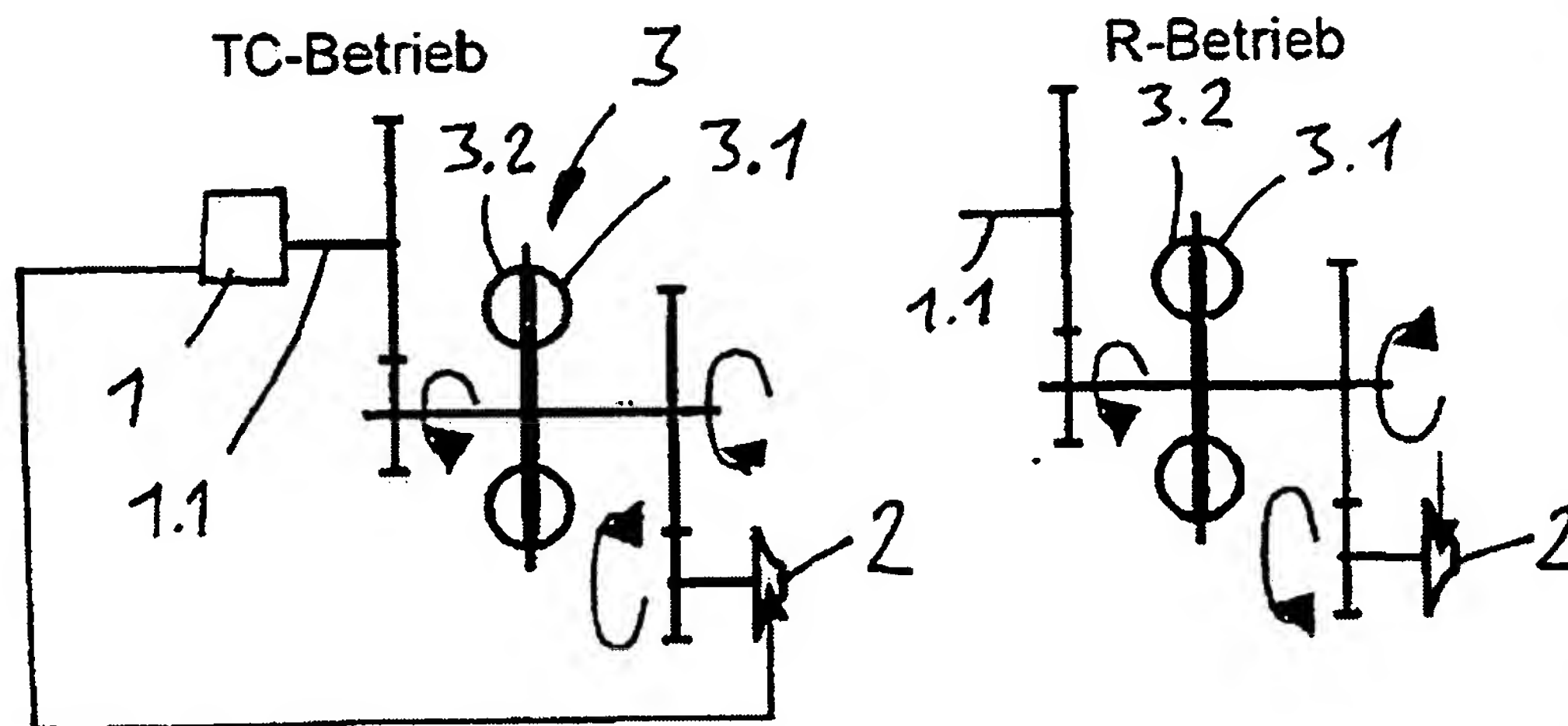
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The documents EP 0 301 547 A, EP 0 297 287 A, and EP 0 272 680 A each describe turbo-compound systems in which the exhaust-gas turbine is reversed in its direction of rotation during braking operation in order to operate as an air compressor. On account of the reversal of the direction of rotation of the exhaust-gas turbine, there occurs also a reversal of the direction of rotation of the two blade wheels of the upstream hydrodynamic coupling.

AMENDED SHEET

Patent Claims

1. A turbo-compound system,
 - 1.1 having a crankshaft (1.1) driven by an internal combustion engine (1);
 - 1.2 having an exhaust gas turbine (2) arranged in the exhaust-gas flow of the internal combustion engine (1);
 - 1.3 having a hydrodynamic coupling (3), comprising a primary impeller (3.1) and a secondary impeller (3.2), which together form a working chamber (3.3), which can be filled or is filled with a working medium, the hydrodynamic coupling (3) being arranged in a driven connection between the crankshaft (1.1) and the exhaust gas turbine (2) in such a way that, when the working chamber (3.3) of the hydrodynamic coupling (3) is filled, for the exhaust-gas turbine (2) driven by an exhaust-gas flow, driving power is transmitted from the exhaust gas turbine (2) to the crankshaft (1.1) characterized in that;
 - 1.4 a switching means for reversing the direction of rotation of the primary impeller (3.1) or of the secondary impeller (3.2) of the hydrodynamic coupling (3) is provided, so that the primary impeller (3.1) and the secondary impeller (3.2) of the hydrodynamic coupling (3) rotate in opposite directions with respect to each other and create a counter-rotating retarder.



TC-Betrieb = turbo-compound mode
R-Betrieb = retarder mode

Fig. 1

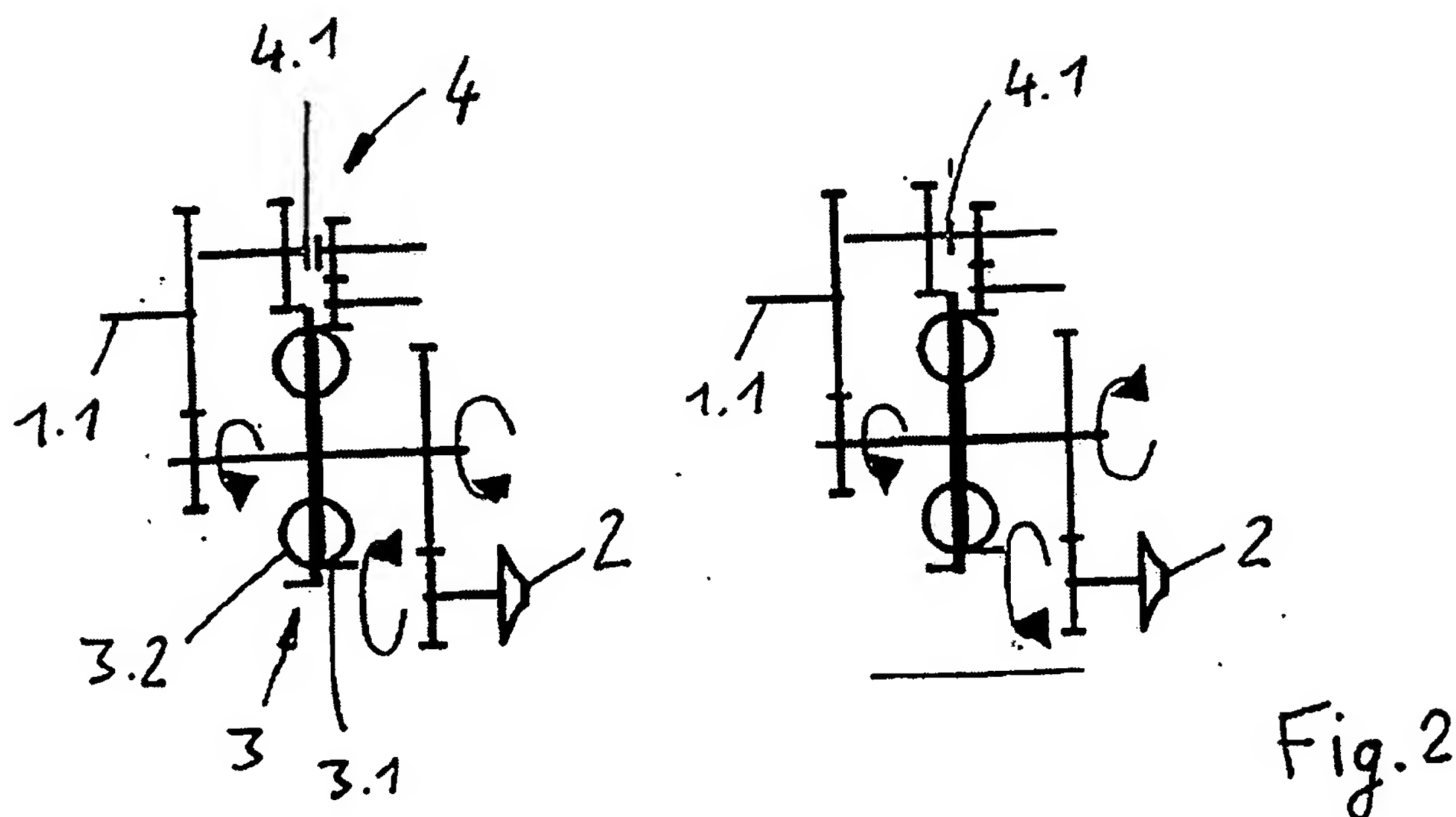


Fig. 2

Fig. 2